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Inventory and Monitoring of Natural Vegetation and Related Resources in an Arid Environment by the Use of ERTS-1 Imagery (Proposal No. 311)

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The following comments with regard to accomplishments are referenced by objective numbers corresponding to those given in NASA Contract Number NAS5-21831, Task 1, Statement of Work - Objectives.

Objective 1. An evaluation of information content of ERTS-1 reconstituted photography in comparison with Apollo 6 and Gemini IV photography has been accomplished for some landform classes through the use of an "image groupability" testing procedure. The results are given in a separate discussion in this report.

Objective 2. Analysis of terrain feature-vegetation relationships has been completed and a complete report is in preparation. Major results are indicated in the separate discussion in this report.

Objective 3. Research involving the interpretation of terrain feature variables has been initiated. Materials are being prepared for use in photo measurement of slope angle, drainage density, and aspect, and in photo inter-pretation of elevation, macrorelief, parent material, and landform type.

Objective 4. Ground data collected in the southern Arizona test site have indicated that many of the plants can be categorized as either evergreen, cool season deciduous, or warm season deciduous. Ground locations have been selected which support vegetation consisting primarily of plants falling into one of the three groups. In each case, the vegetation provides nearly com-plete ground cover. Multidate ERTS-1 data for these locations are being analyzed to determine the success with which phenological changes (specifically foliation-defoliation) can be detected. Methods of detection involve photo interpretation, densitometry, and analysis of ERTS-1 digital data. Work involving the first two methods has begun. The ground locations have been selected to provide the greatest likelihood of success. If such success is

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realized, the methods will be employed in assessing the value of phenological pattern detection in vegetation identification and inventory.

Objective 6. Results from image groupability testing (discussed under Objective 1) have been utilized to stratify an Apollo 6 scene and an ERTS-1 scene of the same area. The approach has provided an objective means of stratification. This will enable a comparison of the space photo types when they are used as the first stage in multistage sampling of vegetation-soil systems.

Objective 7. Computer assisted analysis of ERTS-1 MSS digital data has been initiated. ERTS-1 data for a 300 square mile area in the vicinity of Tombstone, Arizona, is being classified utilizing the CALSCAN program developed at the Center for Remote Sensing Research, University of California, Berkeley. The data is being classified in terms of vegetation subjects; ERTS data for ground locations of known vegetation are being used for training fields for the computer program classifier. Although results have not yet been achieved, several observations may be useful to make.

Training fields have been selected from a color television monitor display of MSS bands 4, 5, and 7. The mean number of resolution element per field was 7; the mode, 4. Small training field sizes were necessary in this naturally vegetated area where vegetation distribution reflects the complexity of slopes, aspects, drainage patterns, soil, and geologic differences. More time and care were necessary for exercising the care required for accurately locating smaller sized training fields. Good quality color infrared 1:110,000 NASA aerial photography greatly facilitated the job by providing a detailed picture of the area against which the patterns of colored squares on the monitor could be compared. The minute detail on the aerial photographs frequently had to be considered in order to interpret the display on the color monitor. Often, the approximate 1.1 acre area included by each resolution element was too large and made it quite difficult to avoid unwanted data in training fields of minimum size (i.e., 4 samples per field). This was true primarily for two reasons: (1) the complexity of the landscape, and (2) the heterogeniety of some image classes considered to represent unique vegetation types. In the latter case, the components of the image class need to be sampled separately, a training class established for each, and each classified separately by the image classifier. Then the classified units can

be regrouped to represent the unique vegetation types. A resolution element size of 1/4 acre would have served this purpose much better. Approximately ten minutes were expended in the selection of each training field from the densely sampled study area.

Results from a comparison of classifications of ERTS imagery from different seasons has not been completed.

The following comments with regard to results are referenced by objective numbers corresponding to those given in NASA Contract Number NAS5-21831, Task 1, Statement of Work - Objectives.

Objective 1. Part of Objective 1 is an evaluation of space imagery for information content relevant for mapping of landform and natural vegetation features. The imagery being compared is ERTS-1 (a single date of photography), Apollo 6, and Gemini IV. In pursuit of the evaluation, we have developed a methodology which we call "image groupability" and which is designed to minimize the effects of interpreter capability differences while maximizing the potential for statistical comparisons of information content among the space imagery systems.

A portion of the testing was designed to compare photography complexity based on the mean number of image groups established by the 13 interpreters. It is assumed that this index of image complexity is directly and positively correlated with photo information content. Statistical analysis showed that the Apollo was significantly ($P>0.05$) more complex than either the ERTS or Gemini, which were not different from each other:

	Apollo	>	ERTS	=	Gemini
Mean number of image groups established	10.0		7.8		7.5

However, in another test, the interpreters were forced to assign the photo image representatives into one of five categories. Photo aids defined the categories, and the task was to assign each image representative to the most appropriate category based solely on comparative image characteristics. Partial results of the trial are shown in Figure 1. The interpreters generally were not aware that the categories represented macrorelief classes. It is evident from the figure that for the photography and landform variables tested, interpreters' performances varied more with macrorelief classes than with imagery type (ERTS, Apollo 6, Gemini IV).

Figure 1. Image groupability trial involving three types of space photography and 13 photo interpreters. For each interpreter, the assignment was to place 45 photo chips into one of five categories for each phototype. Photo aids defined the categories and the task was to assign each chip to the appropriate category. The interpreters generally were not aware that the categories represented macro-relief classes.

macrorelief classes
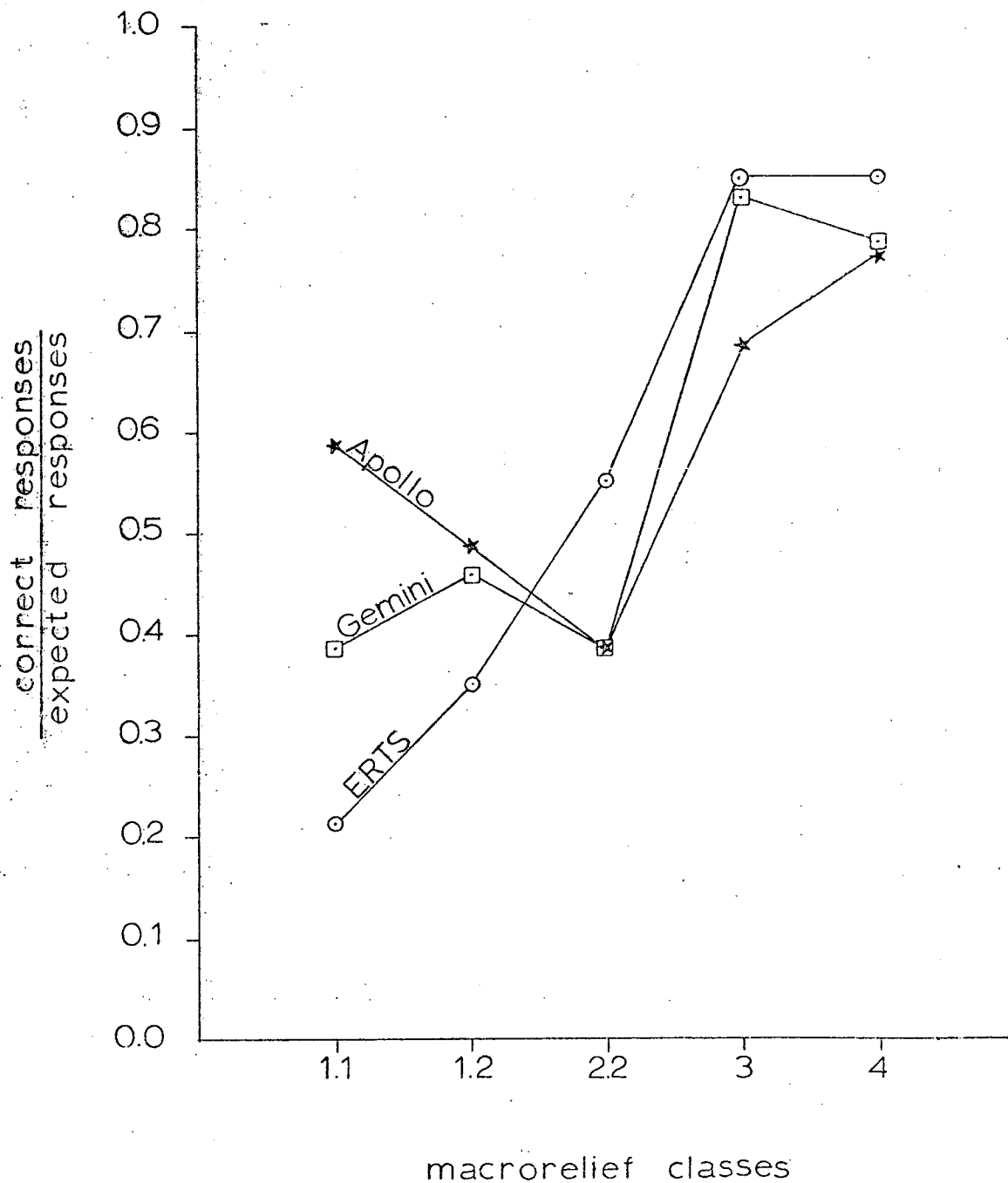
Objective 2. There are two basic sets of information with regard to terrain feature-vegetation relationships: (1) individual plant species-terrain feature variable relationships, and (2) vegetation type-terrain feature variable relationships. Results of the first set indicate a set of species which best differentiates or discriminates groups of specified terrain feature variables. These species include agave, mountain mahogany, mortonia, and manzanita. Results of the second set of relationships indicate the degree to which the terrain feature variables can differentiate or discriminate vegetation types. Elevation was found to be the best discriminant of the vegetation types.